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NASA Procedural Requirements

COMPLIANCE IS MANDATORY**NPR 8831.2E**Effective Date: November 18,
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 (NASA Only)

Subject: Facilities Maintenance and Operations Management

Responsible Office: Facilities Engineering and Real Property Division

[| TOC](#) | [Preface](#) | [Chapter1](#) | [Chapter2](#) | [Chapter3](#) | [Chapter4](#) | [Chapter5](#) | [Chapter6](#) | [Chapter7](#) |
[Chapter8](#) | [Chapter9](#) | [Chapter10](#) | [Chapter11](#) | [Chapter12](#) | [AppendixA](#) | [AppendixB](#) |
[AppendixC](#) | [AppendixD](#) | [AppendixE](#) | [AppendixF](#) | [AppendixG](#) | [AppendixH](#) | [AppendixI](#) | [ALL](#) |

Appendix G. Performance Measurement

G.1 Facilities Maintenance Management Metrics

This appendix provides maintenance management metrics from various sources. Centers and Component Facilities should consider their use, as applicable, as a means of measuring performance.

G.1.1 Facility Condition

The annual maintenance funding and resultant trends are a function of the DM and the needs of the Center. If the DM is high and increasing or staying the same, a positive trend would be observed. A downward trend would be expected if the backlog is low or decreasing. Elimination of the DM is not always possible or desirable, since DM can provide an ability to balance resources in the long term. The following represents the applicable metrics and corresponding benchmarks:

- a. Annual Maintenance Funding (\$) should be between 2 percent and 4 percent.
Current Replacement Value (\$)
- b. Annual Maintenance Funding (\$) should show a downward or stable trend.
Current Replacement Value (\$)

G.1.2 Work Performance

The following metrics and corresponding benchmarks are used to trend work performance:

- a. Emergency TC Response (hours) should show a downward trend.
- b. Emergency TC Completion (hours) should show a downward trend.
- c. Average completion time for routine TC (hours) should show a downward trend.
- d. Average completion time for repairs (days) should show a downward trend.

- e. Jobs Completed as Scheduled (Number) should be 100 percent.
Total Jobs Scheduled (Number)
- f. Service Requests Completed (Number) should be 100 percent.
Service Requests Committed (Number)

G.1.3 Work Element

G.1.3.1 The following metric may have a positive trend if repair rates are high, equipment/facilities systems are not realizing their full useful life, or there is very little PT&I usage. A negative trend should develop if PT&I is increasing and repair rates are stable or decreasing. The benchmark is between 15 percent and 18 percent:

Preventive Maintenance (\$)
Total Maintenance Cost (\$)

G.1.3.2 The following metric should develop a positive trend as the maintenance program shifts from reactive and time-based maintenance to condition-based maintenance. The benchmark is between 10 percent and 12 percent:

Predictive Testing and Inspection (\$)
Total Maintenance Cost (\$)

G.1.3.3 The following metrics should develop a negative trend as the maintenance program shifts from reactive and time-based maintenance to condition-based maintenance:

- a. Programmed Maintenance should be between 25 percent and 30
 Repair (\$) percent.
Total Maintenance Cost (\$)
- b. Repair (\$) should be between 15 percent and 20
Total Maintenance Cost (\$) percent.
- c. Trouble Calls (\$) should be between 5 percent and 10
Total Maintenance Cost (\$) percent.

G.1.3.4 The following metric should show an upward trend if a backlog of this type of work exists, and a negative trend if not much of this type of work exists at the Center. The benchmark is between 15 percent and 20 percent:

Replacement of Obsolete Items (\$)
Total Maintenance Cost (\$)

G.1.3.5 The following metric should show a negative trend, demonstrating increased focus on maintenance, and should be distinguished from customer reimbursed service requests. The benchmark is between 0 percent and 5 percent:

Service Requests (\$)
Total Maintenance Cost (\$)

G.1.4 RCM Performance Metrics

RCM analysis is an excellent indicator of performance.

G.1.4.1 Equipment Availability. The following metric is an indicator of equipment availability. The benchmark is 96 percent:

Hours Each Unit of Equipment is Available to Run at Capacity
Total Hours During the Reporting Period

G.1.4.2 Maintenance Overtime Percentage. The following metric is an indicator of maintenance overtime percentage. The benchmark is 5 percent or less:

Total Maintenance Overtime Hours During the Period
Total Regular Maintenance Hours During the Period

G.1.4.3 Emergency Percentage. The following metric is an indicator of the level of effort dedicated to emergency work. The benchmark is 10 percent or less:

Total Hours Worked on Emergency Jobs
Total Hours Worked

G.1.4.4 Percentage of Candidate Equipment Covered by PT&I. The following metric is an indicator of the amount of candidate equipment covered by PT&I. The benchmark is 100 percent:

Number of Equipment Items in the PT&I Program
Total Equipment Candidates for PT&I

G.1.4.5 Percentage of Emergency Work to PT&I and PM Work. The following metric is an indicator of the amount of emergency work relative to PT&I and PM work. The benchmark is 20 percent or less:

Total Emergency Hours
Total PT&I and PM Hours

G.1.4.6 Percentage of Faults Found in Thermographic Surveys. The following metric is an indicator of the percent of faults found through infrared thermography. The benchmark is 3 percent or less:

Number of Faults Found
Number of Devices Surveyed

G.1.4.7 Percentage of Faults Found in Steam Trap Surveys. The following metric is an indicator of the percentage of faults found during steam trap surveys. The benchmark is 10 percent or less:

Number of Defective Steam Traps Found
Number of Steam Traps Surveyed

G.1.4.8 Ratio of PM/PT&I Work to Reactive Maintenance Work. The following metric is an indicator of the percentage of planned work relative to unplanned work:

$$\begin{aligned}
 &A = 70\% \text{ PM/PT\&I} \\
 &B = 30\% \text{ Reactive Maintenance} \\
 \text{where, } A\% &= \frac{\text{Manhours of PM/PT\&I Work}}{\text{Manhours of Reactive + PM/PT\&I Work}} \\
 B\% &= \frac{\text{Manhours of Reactive + PM/PT\&I Work}}{\text{Manhours of PM/PT\&I Work}} \\
 A\% + B\% &= 100\%
 \end{aligned}$$

G.1.5 Safety

Reportable Incident Rate (RIR) for O&M and Support Services Contracts:

$$\text{RIR} = \frac{\text{Total Annual No. of Injuries Incurred} \times 200,000}{\text{Total Annual No. of Hours Worked}}$$

Lost Workday Case Incident Rate (LWCIR) for O&M and Support Services Contracts. LWCIR represents the number of injuries and illnesses per 100 full-time equivalent workers.

$$\text{LWCIR} = \frac{N}{EH} \times 200,000$$

Where N = the number of injuries and illnesses.

EH = the total hours worked by all employees during the calendar year.

And 200,000 is the base for 100 equivalent full-time workers (working 40 hours per week, 50 weeks per year).

G.2 Budget Execution

The following metrics indicate how well the facilities maintenance budget is being executed:

- a. $\frac{\text{Prior Year Execution (\$)}}{\text{Prior Year Budget (\$)}}$ should be 100%.
- b. $\frac{\text{Current Year Expenditures to Date (\$)}}{\text{Current Year Budget to Date (\$)}}$ should be 100%.

G.3 Other Metrics

The following are miscellaneous metrics used by organizations to measure performance. Their use by Centers is highly encouraged:

- New Construction + Service Requests or New Work (\$ or hours)
- a. should show a downward trend (↓).
- PM + PT&I + PGM + Repairs + ROI Maintenance (\$ or hours)
- Repairs + Trouble Calls
- b. Corrective Actions (\$) should show a downward trend (↓).
- PM + PT&I + PGM + ROI or Preventive Actions (\$)
- Average Age of Equipment
- c. (years) should show a downward trend (↓).
- Average Useful Life of Equipment (years)
- d. The number of disabling accidents per year should show a downward trend (↓).
- e. The number of routine trouble calls per year should show a downward trend (↓).
- f. The number of work orders per year or month should show a downward trend (↓).
- g. The number of emergency trouble calls per year or month should show a downward trend (↓).
- h. Customer satisfaction, as measured by a numerical grade assigned to positive or negative feedback should show a positive, or upward, trend (↑).
- i. The number of unplanned electric power outages should show a downward trend (↑).
- j. The number of environmental violations should be zero.
- k. The number of OSHA violations should be zero.
- l. Maintenance Overtime (hours) should be less than 10% of Total Maintenance (hours) payroll costs.
- m. PMs Completed (number) should show an upward trend (↑).
- PMs Scheduled (number)
- n. Scheduled Work (hours) should not exceed a locally determined benchmark.
- Total Work (hours)
- o. Actual Cost of Work (\$) should be +/- 10%.
- Estimated Cost of Work (\$)
- p. Jobs Planned and Estimated (number) should not exceed a locally determined benchmark.
- Total Jobs (number)
- q. Jobs Planned and Estimated (\$) should not exceed a locally determined benchmark.
- Total Jobs (\$)

- r. Requisitions Met from Stock (number)
Total Requisitions (number) should not exceed a locally determined benchmark.
- s. Requisitions not in stock (number)
Total Requisitions (number) should not exceed a locally determined benchmark.
- t. Supervision (hours)
Direct Labor (hours) should be less than 10%.
- u. Downtime Caused by Breakdown (hours)
Total Downtime (hours) should not exceed a locally determined benchmark.
- v. Breakdown Labor (hours)
Total Labor (hours) should show a downward trend (↓).
- w. Maintenance Cost (\$)
Center Mission Cost (\$) should not exceed a locally determined benchmark.

G.3.1 The following two metrics shall be carefully used on a job-by-job or like-work basis. This may create conflict between shops and management. Care should be exercised to preclude adversarial relationships between the shops and management.

- a. Actual Hours per Job (hours)
Scheduled Hours per Job (hours) should be +/- 10%.
- b. Maintenance Work Orders Completed (number)
Maintenance Work Planned and Scheduled (number) should show an upward trend (↑).

G.3.2 The following two metrics should be trended with the locally accepted employment index factor:

- a. Material Cost (\$)
Direct Labor Cost (\$) should not exceed a locally determined benchmark.
- b. Maintenance Cost (\$)
Total Maintenance Work hours (hours) should not exceed a locally determined benchmark.

G.3.3 Metric 3.2.b., when evaluated with metric 3.3.a. below, will help determine peaks of work resulting from the Center mission or weather-related work. This evaluation can help in the planning process and use of alternative labor or contract methods.

- a. The monthly cost of maintenance operations should not exceed a locally determined benchmark.
- b. Equipment Covered by PT&I (number)
Items of Equipment Potential for PT&I (number) should show an upward trend (↑)

G.3.4 A downward trend of the spare parts inventory is desirable, provided that the maintenance response time and completion times are not adversely affected. Given that, the desired metric as follows:

- a. The inventory value of spare parts should show a downward trend.

| [TOC](#) | [Preface](#) | [Chapter1](#) | [Chapter2](#) | [Chapter3](#) | [Chapter4](#) | [Chapter5](#) | [Chapter6](#) |
[Chapter7](#) | [Chapter8](#) | [Chapter9](#) | [Chapter10](#) | [Chapter11](#) | [Chapter12](#) | [AppendixA](#) |
[AppendixB](#) | [AppendixC](#) | [AppendixD](#) | [AppendixE](#) | [AppendixF](#) | [AppendixG](#) |
[AppendixH](#) | [AppendixI](#) | [ALL](#) |

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